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THE APPLICATION OF A BONUS SYSTEM TO FACTORY MAINTENANCE WORK

BY

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PREFACE

In the maintenance departments of the average industrial plant will be found about the same sort of organization and wage system that obtained in the manufacturing departments before the so-called "efficiency craze" swept over the country. The Superintendent, Mechanical Engineer, or Master Mechanic has one or more foremen under his direction through whom orders are given to the workmen. The latter are usually paid by the hour, and are left very much to themselves in the performance of their duties. Few manufacturers have sensed the possibility of expediting the tasks of these workmen through the medium of a modified bonus system similar to those applied with so much success to manufacturing operations. But in view of the keen competition which now confronts all industries, it is imperative for managers to reduce operating expenses in every way possible, and the reduction of maintenance expense through the proper application of a bonus system is a real possibility, especially in large plants.

It was the writer's privilege to have been associated in the working out and application of a bonus system to much of the maintenance work in a large farm implement factory, and it is his purpose in this thesis to present such of his work and experience as appear to be of particular interest or value.

There may be valid reason for differences of opinion as to the writer's conclusions for they are based upon limited observations and experience. But it is his belief that the conditions observed and studied are typical and that the principles underlying

the conclusions are fundamental. They are, therefore, offered in the hope that they may have some merit.

Part I is devoted to a discussion of the selection of a suitable system. Part II deals with the specific application of such a system. Part III, in the form of a manual, presents the requirements of an organization for, and the machinery for the execution of, a bonus system applied to factory maintenance work. This is an adaptation, similar in essentials, of a manual prepared by the writer and actually in use for some time in connection with his work.

The writer acknowledges his indebtedness to Dean C. R. Richards and Director B. W. Benedict of the University of Illinois for helpful criticism.

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THE APPLICATION OF A BONUS SYSTEM TO FACTORY MAINTENANCE WORK

PART I

THE SELECTION OF A WAGE SYSTEM

I. Meaning and Importance of Factory Maintenance Work.

A brief statement of the meaning and importance of factory maintenance work is very much in order in the beginning for the reason that a proper understanding and viewpoint of the work is thus afforded.

Maintenance work in a strict sense would include only the care and attention required to keep the factory equipment in running order. In this discussion, however, the term will be used in a broader sense to cover practically all work other than the regular manufacturing operations. In other words, the making of new tools, dies, jigs, and fixtures as well as their repair, and the building and installation of special machines or equipment for operating purposes, as well as the repair and upkeep of the regular equipment, will be considered maintenance work.

Maintenance of equipment, intelligently controlled and properly executed, is essential to successful factory operation. As the selling and shipping departments depend upon the production department so is the latter dependent upon the men who "make the wheels go 'round". Of what avail are machines of the necessary kind and number, men prepared and ready to run them, material avail-

able for use, production orders in abundance and well planned schedules, if careful attention is not given to the equipment? The burning out of a motor or a badly overheated bearing may shut down a department for hours. The failure of a machine, due to neglect, may throw a gang or an individual out of a job for a day or more. In fact, delays of this sort occasionally result in seriously tying up production. It is, therefore, of prime importance that the equipment receive the necessary attention, if it is to function properly.

II. Statement of Conditions to be Met.

In selecting a wage system for this class of work what are the results desired and what conditions must be met? Inasmuch as factories are maintained to convert material into more usable form for a profit it might be stated that the ultimate result desired is the reduction of maintenance charges to a minimum consistent with proper operation. To attain this end the system must be adaptable to the work and the workmen so that real efficiency will be possible, but must not involve too much overhead expense. In order that maintenance charges may be known and their reduction measured the system must furnish reliable cost data.

There are further conditions to be met. To any one familiar with factory work it is obvious that there is a great difference in operation between regular manufacturing on the one hand and maintenance work on the other. To a greater or less degree regular production work can be planned and carried out according to schedule if there is no trouble with men, equipment, or material.

Even a jobbing shop can and must schedule work on the parts of a machine so that all will come together at the proper time for assembly; the problem is only more difficult, not fundamentally different in principle. But a good share of maintenance work cannot be easily or successfully scheduled. Trouble may be anticipated and much of it avoided by regular inspection and attention to such equipment as elevators, line shafting, loose pulleys, motors, fans, machine bearings, belting, and conveyors; but no one can tell when a machine will be overtaxed, resulting in a broken pinion or a bent shaft. Then an important die may suddenly chip out or crack in two. Again, the foundry blower may refuse to function properly just before a heat is to be taken off, when everything depends on a full amount of air supply. There is, of course, the regular work to be done, but emergencies are likely to develop at any moment which necessitate the laying aside of work in hand, with attendant loss in efficiency due to frequent changing of jobs. The making of a new line of tools or dies can be scheduled, but where perforce the identical men who build them are liable to be called on in emergencies and for numerous odd jobs, such as changes or repairs, it is not hard to imagine how difficult it would be to keep to a schedule.

The human factor must also be considered. In maintenance work it is especially desirable that there be a spirit of loyalty and co-operation, and that every fair means be employed to develop it. In a large plant there is such a variety of work that it is necessary to specialize. For instance, among the toolmakers there will be such divisions of work as the making and repair of

1. forging machine dies, 2. bulldozer dies, 3. drop forging dies, and 4. press dies. The machine repair men become specialists on various kinds of machines. It takes years for these men to become so well trained that they know intimately the requirements of their particular tasks. Such men cannot be replaced easily, and are often of more value than the management cares to admit. It is necessary that they receive compensation for their services in keeping with other skilled workmen, if they are to be retained. As a class, they are intelligent, more or less independent, and must be treated with consideration to get the best results. Almost without exception such men rightly resent being told or shown just how each small detail of their work should be done. The wage or bonus system to be selected must therefore assure the men a fair wage return-- a little better than the market rate in fact--, must employ methods the least antagonistic to this class of workmen but still sufficiently accurate, and must be so maintained as to cultivate the loyalty and confidence of the men.

III. Inspection of Various Wage Systems

An examination of the wage and bonus systems, beginning with straight day rate, reveals numerous plans developed and designed to secure greater results from the men, or to pay in proportion to effort, particularly mental effort.

Straight day rate or time rate, in which workmen are paid for the time spent at work, has been applied with varying success in the past. But in the main this method of payment has given way to other systems based on a definite service equivalent for

the time paid for. Time rate has been more successful when modified in one of the following ways:

a. The keeping of individual performance or efficiency records with frequent adjustment of wages.

b. Setting the pace by machinery.

c. The occasional addition of a bonus for good performance.

d. Sharing in the profits.

Another modification of day work, rapidly disappearing, however, is the contract system, in which work is let out to a contractor for a fixed sum. Driving or sweating of the workmen under him usually results.

Straight piece rate was early employed by manufacturers when close supervision over and contact with their men became impossible. Theoretically, nothing would seem fairer than to pay for production rather than time. The principal evil in this system is the method of determining the price, or piece rate. Set from former records on day work or the foreman's guess, the rate is bound to be wrong in the majority of instances. Cut follows cut until all incentive is removed to any more effort than will bring in the wage it is found the employer is willing to pay.

Another of the early methods employed to stimulate effort is that known as the Halsey plan whereby a standard time is set, based on past records, and the workmen given a premium of one-third or one-half the time saved. As the standards are in reality set by the men themselves, the tendency is to see that they are high enough, so a system known as the Rowan plan was developed. The standard is set in the same manner but the premium is fixed as a

percentage of the workman's rate equal to the percentage of time saved. This removes the incentive toward fixing the standard too high, but does not encourage the worker to unusual effort.

The present systems which in general are the successful ones are based on a definite knowledge of production conditions and performance.

Straight piece rate on repeat operations is often satisfactory when

a. Conditions and operations are standardized,

b. Rates accurately set,

c. Day rate guaranteed as a minimum,

d. Rates guaranteed for a definite period and changes avoided, and

e. Output inspected and quality rigidly maintained.

A slight modification of straight piece rate is the paying of a higher rate after a certain quantity per unit of time has been gotten out -- the higher rate applying only on the number above a fixed quantity produced.

The Taylor differential piece rate system not only creates a strong incentive to the attainment of efficiency and rapid production but imposes a penalty for failure to do so. An attractive piece rate based upon highly standardized conditions and most careful time and motion study, is offered the worker who can equal or surpass a fixed production pace. To the worker who falls even slightly below the established mark is paid a rate below the equivalent day rate customary to one of his class. The system is therefore highly stimulative and is applicable only where labor

cost relative to overhead is low.

The Gantt system lessens the rigor of the Taylor differential system by guaranteeing the usual day rate as a minimum. It was developed to bridge the gap between unskilled and skilled operation. While developing skill, the workman is thus encouraged to meet the production schedule which calls for the high piece rate.

The Emerson plan also guarantees day rate as a minimum and determines by accurate methods the proper time in which a job should be completed. This is called the standard time and the worker equaling it is rated as one hundred percent efficient for which he receives a bonus of twenty cents per dollar of wages. No worker is retained who falls below an average of sixty-six and two-thirds percent, the point where bonus calculations commence. He is encouraged to greater effort by a gradually increasing percentage of bonus up to one hundred per cent from which point there is a one per cent increase for every one per cent in efficiency. There is, of course, no punishment for inefficiency except the loss of his job.

IV. Conclusion.

Which system is most adaptable to factory maintenance work? Straight time rate is by far the simplest and least objectionable to the men but does not encourage best results. It is granted that there is less tendency to slight one's work under the day work plan than any other, and consequently less rigid inspection is required. But on the other hand, hours and sometimes days are in reality wasted, for instance in putting an unnecessarily

fine finish on a set of dies, or the repair crew working in an isolated part of the plant may decide that such a place is suitable to hold discussions on the war or politics. There is no particular incentive in time rate which causes a man to concentrate on the task confronting him. It is true that close supervision and frequent wage adjustments as a reward for good performance help to stimulate efficiency. But wage adjustments are seldom made to the satisfaction of all parties concerned. There may be very good reasons why one man is worth and should receive five cents an hour more than another, but often the one receiving the lesser wage believes he is worth just as much as his more fortunate partner. Time rate does not furnish cost data readily nor accurately and hence is lacking in that respect. The principal objections, therefore, to this system are first, lack of incentive to eliminate waste time and effort, and second, unsatisfactory cost data. Its particular advantage is ease of application.

The Halsey and Rowan plans are obviously inaccurate and unfair and consequently need not be considered.

Straight piece rate, properly determined and applied, might be adaptable to maintenance work if it were not for the very pronounced prejudice which the class of workmen in question have toward such a system.

The Taylor differential and Gantt systems can not be considered for the reason just stated in connection with straight piece rate; in fact, the Taylor system has caused trouble among the workmen in most plants where it has been tried. Organized labor is bitterly opposed to its adoption. Furthermore, the standardized

conditions demanded by these highly developed systems are well nigh impossible in maintenance work.

The nearest approach toward meeting the conditions named is made by the Emerson plan because, 1. the men are stimulated to exert their best efforts and are rewarded accordingly, 2. the system is not particularly objectionable in character, and 3. reliable cost data is obtainable. The standard, a definite task in a definite time, does not arouse the antagonism that piece rate does; to speak in terms of hours instead of dollars and cents seems less objectionable. Yet the incentive for efficient effort is there just the same and the idea of beating the game-- of being better than one hundred per cent efficient-- is particularly appealing. True enough, cost data obtained through the Emerson system is not gotten with the same ease, and possibly accuracy, as with straight piece rate, but it is vastly more reliable than straight time rate. And another point in favor of the Emerson plan which should not be overlooked is the comparative ease with which it can be installed. As before mentioned, practically all maintenance work in the average factory is done under the time rate plan, and the Emerson system may correctly be called "modified time rate". Hence the transition may be accomplished with fewer changes of a radical character than if a piece rate system were to be established. The chief objections to the Emerson plan are the work involved in figuring efficiency percentages to determine bonus earned and the correct distribution of bonus for cost purposes.

PART II

THE SPECIFIC APPLICATION OF A SYSTEM

I. Introduction.

The Manufacturing Company, hereafter styled the A-B-C Mfg. Co., to which reference was made in the Preface, chose a plan similar to the Emerson for installation in their maintenance departments. Conditions in the plant as a whole were typical of the best managed concerns of its kind. Under a resourceful superintendent a piece price system, based upon exact knowledge of production performance and possibilities, had been applied to all manufacturing departments with such success that the amount of day work was almost a negligible quantity. Piece prices had been set on some of the frequently recurring jobs in the tool department, but further than that nothing had been done in the maintenance departments to get away from straight day work. Representatives of a company of industrial engineers spent a year studying the situation and introducing the system above mentioned. Then the administration and development of the system was taken over by the Manufacturing Company. The discussion to follow is based upon the experience of the first five years in which the system was in operation. This period embraced the extremes of manufacturing -- capacity production one year and very limited production another --, and included a considerable quantity of war work. The system was therefore put to almost every conceivable test.

It is not the purpose of this discussion to enu-

merate the mistakes made, nor to record in chronological order what was done. The reader will be much more interested in learning which plans and methods worked out most successfully.

II. Records.

Records will be discussed first because they form the foundation upon which a system is built. To a large degree the success of any enterprise is dependent upon accumulated information, kept up to date, accurate, comprehensive enough to meet the particular need, and easily accessible. Most certainly is this true of a bonus or wage system. Especially are the records of time studies taken and standards set of vital importance, and in the specific case under discussion these particular records presented a problem that was not readily solved. The reason for this is not apparent until a survey is made of the variety of work performed. The toolmakers make and repair parts for thousands of dies, jigs, and tools, some of which bear identifying numbers but many of which do not. The millwrights and machine repair men further complicate the situation because of the great variety of work they are called upon to perform. For instance, there are several hundred kinds of power-driven machines in this plant, each with numerous working parts subject to repair. Consider also the mechanical equipment used in connection with the machines mentioned, and elsewhere. To record information alphabetically proved a hopeless task principally because there were usually two or more names by which an article was known. Cross indexing helped but became a great burden, and furthermore one was not sure that every possible name was recorded. Indexing by

part numbers was out of the question for the very good reason that not more than one-half of the parts in question had or could have part numbers. A very satisfactory solution of the problem was obtained through the working out of a decimal system of classification of parts worked on, patterned after the Dewey decimal system in use in libraries and the extension of the same to engineering as worked out by Professors Ricker and Goodenough of the University of Illinois. Exhibit 3 of Part III gives in detail the classifications, et cetera. All time studies were recorded under this system, as were also the standard time handbook sheets. By the use of this classification it was possible to identify any part positively -- the decimal number could stand for one thing and that only --, and the system was so flexible and easily extended that numbers could be readily applied to any conceivable piece of work.

The development and application of this decimal system of classification in the way mentioned is the outstanding feature of the records employed, many of which are of equal importance but none of so unusual a character. Part III includes exhibits and explanations of all records used.

III. Classification of Work by Operation.

Following the survey of parts worked upon, necessary for a correct decimal classification for purposes of records, comes the analysis of the work itself and its classification from the standpoint of determining and applying standard time. (The term "standard time" is treated fully in Part III, but it can be explained briefly here as the time set as the standard of performance

for any particular operation or job, and forms the basis for calculating bonus). It was found that the following general divisions covered everything considered:

1. Ordinary machine or bench "repeat" or quantity work.
2. Strictly upkeep work of a routine nature.
3. Non-repeating or irregular machine and bench work and machine repairing.
4. Experimental and emergency work.

IV. Determination and Application of Standards.

Class 1. There is no question as to what method to use in determining standards for Class 1 work; a time study should be made of each operation except plain shaping, planing, turning or other operations of a similar character for which curves or tables are provided. These latter are based, however, on actual performance records. Standard tools or parts of dies such as punches, die and drill bushings, shear and trimmer blades, die blocks, and machine repair parts for stock, are of this class. It is necessary, of course, to make certain that the work is being done in the most efficient way that current conditions permit and to set a standard, keeping in mind future possibilities, quantity made at one time, frequency of recurrence, and by what grade of workmen performed. It must be remembered also that conditions entirely different from those surrounding straight manufacturing prevail; that there may be a best way and a best man to do a particular job, but that average conditions in the maintenance departments do not permit one to rely upon being able to employ them. Therefore, the average standard set will usually appear to be more liberal than would be thought necessary at first glance to one accustomed to quantity production standards.

Class 2. The application of standard time to routine maintenance work presented an interesting problem.

On the one hand:

> Accurate and comprehensive time studies showed what was being done and how it was done.
>
> From these studies it was possible to work out schedules to permit of the work being done most advantageously.
>
> The application of such schedules (when rigidly carried out) assured the management that the equipment was receiving proper care at the proper time, and at the lowest cost.

On the other hand:

> Putting such work on to standard time, subject perforce to no rigorous inspection or supervision, placed a premium on too rapid or casual attention to the work in an effort to secure more bonus.

After experimenting for over a year it was decided that the best way to handle such work was:

1. To determine exactly what duties were to be included in a particular schedule and just how long it should take to perform the same efficiently.

2. To insist that at least the time so specified should be utilized in performing these duties and as much more time taken as was found necessary to do the work correctly. In other words, one hundred percent efficiency was the maximum attainable.

3. To apply a fine, in the form of a deduction from the bonus, for trouble arising due to careless attention to equipment, the amount of the fine to depend upon the seriousness of the trouble and the degree of carelessness proved.

Such schedules were developed and applied successfully, as modified, to:

1. The oiling of all overhead loose pulleys, countershafting bearing boxes, fans and blowers.

2. The oiling of all line shaft bearing boxes.

3. The oiling of all motors.

4. The inspection, oiling, and greasing of all elevators and lifts (including the hoisting machinery, cables, slides, gates, et cetera).

5. The inspection, oiling, and greasing of all conveyors and conveyor machinery, and air hoists.

6. The inspection of all air apparatus for leaks.

7. The operation and maintenance of a highly efficient dust collection system which included piping, separator boxes, and trap boxes for the overflow from the separators.

Much of the work mentioned is considered dangerous, and some of it, very disagreeable; all of it, undesirable or avoided by the men unless well-paid. Actual records prove that the men to whom the schedules were applied earned considerably more than when there were no schedules and that the company paid much less for the actual service rendered. Unskilled men, obtainable at the lowest market wage, were developed into specialists on some of this work through the medium of standard time, and the bonus earnings were enough to bring up their average wages close to those having regular trades.

In some respects the problems of regular maintenance work are similar to those pertaining to straight manufacturing, especially in that scheduling is feasible and necessary. But in production work direct supervision and careful inspection are possible whereas the opposite is usually the case with maintenance work, and hence the method of applying the standard and determining the bonus necessarily must be different.

Class 3. Attention is now turned to the division of work per-

haps the least susceptible of standardization; namely, non-repeating or irregular machine and bench work and machine repairing. In this division are classed the making and repairing of press dies, bulldozer dies, forging dies, hammer dies, drill jigs, gages, and similar equipment; the repair of machines by replacing pinions and gears or rebabbitting bearings; et cetera. Consider the making of dies first. There are thousands of steel and cast parts of implements requiring one or more dies for their processing. No two of these dies are exactly alike. Hence the making of dies is about as far removed from quantity production or "repeat" work as is conceivable. How can equitable standards be determined at a cost which is not out of proportion to the benefit derived from their application? A time study of each job cannot be considered, as such a method is manifestly impracticable. The problem requires thoughtful analysis. Two factors to be considered are:

1. Only one die or set of dies is made at a time; another set may never be made.

2. Many, possibly all, of the detail or elemental operations performed in making one set of dies are similar to those performed in making another set.

As an illustration of the second factor consider the punch and trimmer blades used on press dies. Many of these blades are of uniform thickness; have standardized holes counterbored to a uniform depth for cap screws; have round, square, or slotted punch holes sometimes identical in size; and many have curved outlines which vary but slightly. Yet one blade has four punch holes while another has only one, or the number of screw holes differs; no two are exactly alike.

The solution of the problem lies in determining standards for those detail operations which are common to many jobs. The time study has a most important place in establishing these standards; in fact, the whole structure has its foundation in detailed observations which give accurate and definite information about similar operations. The next step is to make use of this information.

The plan adopted by the writer was as follows. A copy of every Standard Time Handbook Sheet (see exhibit 2) was placed according to similarity of operation in what was conveniently termed the Comparative Handbook. Thus, all trimmer, punch, and blanking blades or plates for press dies were grouped together; all rebabbitting jobs were in one group. As opportunity afforded, one group at a time was studied intensively and where sufficient data on any detail operation was found, a standard for the same was established. When, for instance, it was repeatedly observed that 0.2 Hr. was the average time allowed for laying out, drilling and counterboring a certain size of screw hole, 0.2 Hr. was established as a standard for that detail operation. Where certain information was lacking, note was taken of the fact and an effort made to have a time study made as soon as possible which covered the work in question.

The application of these "detail standards" is suggested by the very process of their determination. In the same manner in which a time study is separated into detail operations, and standards for the same developed, the standard for a job involving many operations can be built up synthetically. The first

step is to analyze the job and list the operations which must be performed. Then the complete standard is built up of detail standards. If all the operations have not been standardized it is necessary to make use of comparative estimates which, of course, requires good judgment. Standards so determined are called "Figured Standards" to distinguish them from those obtained directly from time studies. The employment of comparative estimates for unstandardized details was the means by which many jobs were covered by standard time which otherwise could not have been, and the percentage of inaccuracy was not great enough to warrant discontinuance of the practice. It should be noted that this method is more or less of a temporary expedient which becomes less and less necessary as the establishment of detail standards from accumulating data continues.

On some classes of die work, such as die chipping and die sinking, more dependence was placed upon comparative information such as sketches and photographs, with the necessary dimensions, showing surface worked on, the standard set, and the actual time required to complete the job. It might seem that this form of standard setting is unscientific when compared to time or motion study. But it has proved practicable, and becomes more and more accurate as the data accumulates, whereas time study was actually proved impracticable.

The repairing of dies requires somewhat different treatment. Many dies receive frequent overhauling, including the grinding or sharpening of punches and punch dies, shear and trimmer blades, blanking plates, and similar parts, and the necessary realignment of parts. Such work yields quite readily to standards,

set by studies and comparisons. Other repairs which probably would never recur are hardly worth bothering with unless it is necessary to speed up the work or the job is of such size as to warrant the time spent in setting a temporary standard upon it.

In a similar way the repairing of machines can be handled, but on many jobs the standard set becomes more nearly an estimate than a figured standard, for it is impossible to tell in some cases how much work will have to be done. It is better to figure on what apparently must be done and then add to the original standard if additional work in any quantity develops. Such operations as removing and replacing fly-wheels, gears, pinions, pulleys, and shafts, and the rebabbitting of bearings, are susceptible of standardization in this manner. More leeway for delays and minor details bound to be left out of the calculations must be allowed than in the case of standards for making dies.

The Figured Standard, determined as outlined, is perhaps the best method developed to overcome the difficulty in covering the class of work under discussion.

Class 4. The fourth division of work to be considered includes both that of an experimental and emergency character. This class makes up only a small percentage of the total and hence special treatment is permissible. One of the best mechanics is occasionally given an experimental job to work out largely on his own initiative. As an aid in arousing co-operation to the end that the desired result may be obtained efficiently, a bonus is offered the man in proportion to his efficiency as judged by the foreman or master mechanic under whose direction the work has been performed.

In a similar way, bonus is offered men on emergency work when extraordinary effort is required of all and there is either no standard set or no time in which to figure one. On the recommendation of the proper authority, who is usually the one in charge of the work, a flat efficiency percentage is allowed. This method of applying bonus is, of course, inexact, but within certain limits is practicable and advisable if used with judgment and discretion.

V. Conclusion.

It is the writer's opinion, after experience in both fields of endeavor, that the application of a bonus system to factory maintenance work is a very much more difficult problem than the application of such a system to manufacturing work. Furthermore the cost of establishing standards on maintenance work, especially at first, is excessively high.

Therefore, a company contemplating the installation of such a system on the class of work in question should weigh the matter carefully; should be cognizant of the difficulties to be met and overcome, and should consider the investment made as bringing no appreciable returns for several years.

If the writer were asked to suggest a plan of procedure for putting maintenance work under a bonus system it would be about as follows:

1. Have a survey made of the work passing through the maintenance departments, by competent men preferably within the organization, with particular reference to:

a. Classification according to the four divisions named (page 13) and quantity under each class,

b. Possibilities of standardization in the various classes,

c. Quality of work done,

d. Day work cost of representative jobs and probable savings if put on bonus,

e. Working and operating conditions, and

f. The attitude of workmen and foremen toward the management.

2. If the company decided to go ahead with the plan, after studying the survey, it should be done only with a full realization of the task ahead. The first step would be to select the right man to direct the work, and a great deal of emphasis should be placed on this matter. The project will not be a success unless properly directed. The ideal man for this place would be one with both technical and practical training; he should have experience with and knowledge of wage systems; he should be familiar with maintenance work; he should have the ability to analyze, plan, and then get things done; and by all means he should be fair-minded and tactful. Such a man may already be in the organization or he may have to be gotten outside. He should be given a contract for at least two years with the understanding that additional time would be given if necessary, his commission being to put the system permanently on its feet and to train a subordinate of lesser qualifications who would eventually take charge and carry out the work along pre-arranged lines.

3. The next step, of course, would be to complete the organization of a staff to assist in the work, the number of assistants

depending upon the rapidity with which the system is expected to be established. Usually it would be advisable to start with a small force in a single department and add to the staff as the demands grow for more help and it is seen that these demands can be met to advantage.

4. In the beginning it would be well to cover Class 1 jobs first, and then in line with the survey, cover Classes 2 and 3, keeping ever in mind the value of studies made for comparative purposes.

It is the writer's opinion that every factory, whether operating on a piece work, bonus, or day work plan, should schedule Class 2 jobs (strictly maintenance work) and place them on some sort of bonus plan. The expense to the Company in establishing these schedules is not excessive and the benefits in direct saving in labor -- especially over day work --, and systematic and correct attention to the equipment are very great.

The application of a bonus system to Class 3 jobs (irregular operations) should not be considered until the regular manufacturing operations have been given proper attention -- it is an expensive refinement.

In conclusion it will be stated that the chief advantages to be gained through a bonus system applied to maintenance work are:

1. Lower labor costs after system is established,
2. Valuable information for estimates,
3. Better control of operation in maintenance departments,

4. Shorter interruptions to regular production due to the speeding up of maintenance work.

and the principal disadvantages:

1. High cost of installation and upkeep,
2. Close inspection necessary,
3. Difficulty in administering system fairly, until well established.

With reference to the second advantage mentioned, it will be of interest to state that especially on prospective war orders, when estimates of tools and fixtures required were wanted on short notice, the information based on the comparative handbook was of great value. Figures were wanted in a hurry; in fact, hours were given the estimates when days would have been allowed on ordinary work.

Weighing the advantages and disadvantages, it will be seen that the immediate gain is not great and the determining factor is largely whether the management is ready for and willing to undertake a program looking far into the future.

PART III

A MANUAL FOR THE SPECIFIC APPLICATION OF A BONUS SYSTEM TO FACTORY MAINTENANCE WORK

I. The Administering Department and its Functions.

1. Introduction.

The Department is maintained primarily to promote efficiency through bonus reward among the workmen engaged in making and repairing tools, building special machinery, repairing machines and equipment, and other plant maintenance work over which the Master Mechanic has supervision. The men are guaranteed a day rate of pay and in addition are given the opportunity of earning a bonus on such jobs as are standardized. The attainment of efficiency results in a material saving to the Company and increased earnings for the workmen, as the following illustration shows:

Same Job

Case I. On ordinary day wages

15 Hrs. @ .30	4 50	
plus overhead @ 60%	2 70	
Labor cost of job	7 20	
Hourly earnings of workman		.30

Case II. On bonus

10 Hrs. (Std. Time) @ .30	3 00	
plus overhead @ 60%	1 80	
plus 20% bonus to workman	60	
Labor cost of job	5 40	
Hourly earnings of workman		.36

Net saving in labor to Company	Total	1 80
	Per hour	.18
Increase to workman	Total	60
	Per hour	.06

These figures are based on the assumption that the incentive of a 20% increase in wage return will on the average reduce the time required to do a given job 33-1/3%. Experience has shown this to be a conservative figure. If, after a standard of 10.0 hours is set on the above cited job, a workman still requires 15.0 hours to complete it, he is paid no bonus. As he cuts the time down from 15.0 hours, he is paid a gradually increasing bonus, as per curve and table (see exhibit #1, page 49), until at 11.1 hours, or 90% efficiency (standard time divided by actual time), he is paid 10% bonus. From this point on, the bonus increases 1% for every 1% increase in efficiency. For instance, at 105% efficiency, 25¢ of bonus per $1 00 of wages would be paid. The system is not designed to promote undue strenuousness but rather to reward effort, particularly mental effort, in proportion to results. Standard time is set by the Company to the best of its ability as the time required to perform efficiently a definite task at a reasonable working pace.

2. Determination and Application of Standard Time.

The time study is the basis for standard time and if properly made is of considerable value. The purpose of time study is two-fold: first, to establish a correct standard for the particular task timed, and second, to secure data which will be of value later in a comparative way on similar jobs for which standards are desired. The ability thus to check the proposed standard with former experience is invaluable. Furthermore, if one is given enough reliable information properly arranged, a standard can be built up without a study; and there is a class of work on which timing is

usually impracticable and to which "figured standards" are applicable. Dies, jigs, and some repair work are of this class. A figured study is a theoretical time study based upon actual time study experience.

Standards on jobs which it is known will be repeated are recorded in the Standard Time Handbook (see exhibit #2, page 50), decimally indexed (see exhibit #3, pages 51 to 60). Back of the handbook stands the Live Time Study File, containing nothing but approved studies, indexed like the handbook. The Dead Time Study File contains obsolete studies.

It is essential that all time studies and handbook sheets, live or dead, be preserved; hence Records of both are maintained.

The Comparative Handbooks are arranged according to similarity of operation and contain all available information for use in comparing or figuring standards. They represent a collection of data which is constantly being added to and worked over into more convenient form.

The Follow-Up Record (see exhibit #4, page 61) is designed principally to check standards as to their correctness and secondarily to show the frequency with which certain jobs repeat. The record is therefore of service in figuring time by comparison with existing standards, and keeps the Head of the Department informed as to 1. the high and low efficiencies, 2. the really important jobs on which additional savings may be effected, and 3. those jobs (particularly repair jobs) which need watching because of too frequent repeating.

It is the duty of the Department to establish new

standards in a satisfactory manner as fast as possible and to see that all standards are properly maintained and applied. As an aid in applying standards, orders for new work are routed through the Department.

(See Instructions to Time Study Men)

3. Timekeeping.

An important essential in the bonus system is the work card (see exhibit #5, page 62) which records what is done by the workman, the time spent on each operation, et cetera. Every change from job to job, if only for a short time, is represented by a work card, so that an accurate record of the actual time on every job is thus obtained. These cards are made out by time clerks to whom the workmen report. Time is recorded decimally (see exhibit #7, page 63).

(See Instructions to Time Clerks)

All information on the cards, including total hours per man, wage extensions, et cetera, is checked over in the Department office before the cards are turned over along with the time clock slips to the Shop Timekeeper. Original copies of work cards are kept on file, arranged according to check number and date.

4. Determination and Payment of Bonus Earned.

From the work cards are entered on to Individual Effort Record Cards (see exhibit #8, page 64) the actual and standard hours on every completed bonus job. An average efficiency is obtained from the weekly totals and the bonus earned by each man is determined from the Table (see exhibit #1, page 49). An Individual

Effort Check (see exhibit #6, page 62) showing total actual and standard hours on bonus work and bonus earned for preceding week, is issued each man receiving 25¢ or more. A Bonus Report (see exhibit #9, page 65) listing bonus earnings of each man by departments is forwarded to the Shop Timekeeper in time to make up the payroll. Bonus is included with the hourly wages in the weekly pay envelope.

5. Reports.

A Weekly Summary (see exhibit #10, pages 66 & 67) presents to the Superintendent, Master Mechanic, and Head of the Department a concise statement of the Department's work, average shop departmental efficiencies, total bonus earned, and savings effected. The Monthly Summary Report (see exhibit #11, pages 68 to 70) is more comprehensive, as the average total wage rate per man is included, along with other detailed information. The semi-annual and annual reports are similar to the monthly report, but cover correspondingly longer periods.

6. Meetings.

Meetings to which all members of the department are eligible offer an opportunity for bringing up and discussing matters of interest and profit to all, and are held as frequently as is advisable. Copies of the minutes are sent to the Superintendent and Master Mechanic.

7. Recommendations and Suggestions.

Recommendations or suggestions resulting from daily

observations and relating especially to details of operation are encouraged.

II. Shop Policy.

1. Every Standard Time carried on the books as such is backed up by the Company and cannot be changed unless the method is changed. Short cuts originating with and employed by workmen which do not involve extra Company equipment will not be construed as "change in method" and hence are of advantage to workmen. Standard times immediately become canceled when the method is changed by the Company.

2. Temporary Times current in the shop may be canceled or changed. It is to the interest of all concerned, however, to keep the number of such "times" at a minimum. Therefore, such temporary standards as are found correct should be established as permanent standards without delay; if incorrect, time studies should be taken and proper standards determined.

3. Arrangement for the standard, if any, must be made at or very soon after the commencement of a job. If the standard is taken from the handbook it should appear on the first work card; if workman wants to apply a time in his possession which is not on the Company books, the matter should be taken up immediately with the Department and his time disposed of -- he cannot wait until the job is half or more finished before doing so. For any other situation arising; such as, timing, figuring a standard, or setting a temporary standard, there should be no delay in arriving at an understanding with the workman. The practice of keeping the workman in ignorance

of the time or of the intention to apply time is inexcusable and will not be tolerated.

4. Defective work on bonus jobs or operations should be penalized, but the method to be employed can not be laid down as a hard and fast rule. Each case calls for a consideration of its individual merits before reaching a decision.

5. Bonus shortages or complaints regarding standard time should be reported through the foreman rather than directly to the Department.

6. Allowing delays calls for the exercise of good judgment. It should not be done unless otherwise a positive injustice to the workman would result. No delay will be allowed unless approved by the Head of the Department.

III. Instructions to Time Study Men.

1. Time study work consists of:

a. The accurate analysis and detailed timing of operations or jobs to be put on standard time, after operations have been standardized,

b. The systematic recording, on proper forms, of notes taken,

c. The careful consideration and determination of allowances and the resulting standard times to be recommended, and

d. The satisfactory establishment of these standards in the shop.

The work must be approached in a scientific manner,

with the viewpoint of one who wishes to attain the ideal, but the standards set must be practicable.

2. Special Qualifications for time study work are: technical education or training, practical shop experience, well developed power of observation, keen insight into human nature, a spirit of fair play, and tactfulness. Co-operation with the workmen and foremen is essential.

3. The place of the time study man. The time study man is not a foreman, nor an assistant foreman. He is a representative of the Company sent into the shop to make an expert investigation and his conduct at all times should be such as to command respect.

4. General instructions for taking time studies. A thorough knowledge of shop environment and conditions is a desirable asset. It will be well to become familiar with the name and check number of every workman, the shop number, make, and detail workings of every machine, the tool room equipment and all facilities for work, the location and mechanical equipment of the departments of the plant outside the maintenance departments.

When a job is to be timed it is usually advisable to be on the scene at its commencement. The only exception is "repeat" or "quantity" work, when it is often best to let the workman become familiar with the operations first. The job commences with the change in work cards, and at this point note the hour and start the stop watch. The sum total of detail observations must equal the time, by the clock or ordinary watch, spent in making the study. Record

these observations on the right hand pages of note book, reserving the left hand pages for data such as the date, name and check number of workman, shop order number, sketches, and incidental notes or references.

Give your undivided attention to the work. Be sure to record the exact time for each detail and so analyze the work that the unnecessary or irregular items can readily be distinguished and separated. Figure out the best way of doing the job and note especially what conditions, if any, hamper best results. Be on the alert.

5. Specific Instructions for taking Time Studies.

a. Bench work -- General. In this work there is usually no opportunity to analyze the operations before the study is started and hence rapid thinking is necessary in order to record the details intelligently. Machine work, such as drilling, often forms a part of the job and it is therefore important to arrange and record observations so that separate standards may be set for the different operations such as laying out, drilling, et cetera.

b. Bench work -- Die Chipping. Carefully note the condition of the castings and how closely the pattern fits to begin with. Closely watch each "try for fit" to see where and how much it is necessary to "let down" the surface. A large wheel should be used whenever possible. In some pocket dies it is unnecessary for all surfaces to be finished -- only the sand need be removed.

c. Bench work -- Oxy-acetylene Welding. In this work a job

is obviously a "go" or it is not a "go". However, skillful manipulation results in time and metal saved and in many cases less work for other workmen in finishing the job. For welding, the flame must be neutral because if there is too much acetylene gas present the effect will be to carbonize, and if too much oxygen, to oxidize the metal. For cutting, an excess of oxygen is of course used at intervals. Be sure to get the dimensions of the weld or cut, kind of metal, and other data which will aid in determining welding and cutting schedules.

d. Bench work -- Plaster Pattern Making. The workman should be supplied with the metal pattern and his instructions, and should not have to hunt either. A little judgment and care in the mixing will result in materially decreasing the time required for the plaster of paris to set. Two coats of shellac on the finished patterns are necessary. There are many short cuts in this work.

e. Machine work -- General. A large number of factors enter into cutting operations; such as, speed, feed, depth of cut, composition of material being cut, kind and shape of tool used, rigidity of machine, size of belt and condition of same. Be satisfied that the "cutting time" is what it should be before finishing the study. In other words, a little experimenting will usually be in order along with a study of the factors mentioned above, especially when there is much stock to remove or long runs to make. Begin with moderate speed and feed, and increase the same gradually until the maximum, consistent with the good of the equipment and the requirements of the work, is reached. This should be done tactfully, without antagonizing the workman if possible. Emphasize the point that

it is the machine which is being speeded up, whereas all that is asked of the man is reasonably fast and intelligent handling. The quantity to be made should determine largely how much experimenting should be done to approach maximum results in "cutting time". Observe as many pieces as are necessary to give a fair average and basis for the standard. Be sure to record the shop number and kind of machine, rough and finished size and kind of material of the piece worked on, speed, feed, and depth of cut.

f. Machine work -- Drill Press. Usually the work can be analyzed and investigated before actual timing is commenced. The drill should be correctly ground. The power feed should be employed as much as possible. Be sure to record the size of drill and whether it is carbon or high speed. If a jig is used, state that fact.

g. Machine work -- Engine Lathe. Here again the work can usually be analyzed before timing. A good color in the chip may or may not -- more likely does not -- indicate maximum results. Notice particularly the grinding and setting of the tool. If a finely finished surface is required, it can be secured at as rapid a rate as a roughing cut, often faster, by increasing the speed to offset the decrease in feed.

h. Machine work -- Turret Lathe. In this work a complete operation does not last long and the details develop rapidly. Hence it is almost imperative to watch several complete operations before timing, listing the details in order, and lining up columns for the observed time. It will be found helpful to let the watch run continually during a complete operation, noting and recording the time at the completion of each detail and snapping back to zero at the

completion of the entire operation. Analysis of details should be made in a logical manner so as to avoid running them together unnecessarily.

i. Machine work -- Miller. Be sure to get the direction of rotation and of table travel, description of cutter (diameter, length, bore, and whether high speed or carbon); also whether oil or soap water is used.

j. Machine work -- Planer. Here the set-up is usually a rather important detail and should be carefully studied, especially if there is any decided advantage in planing several pieces at a setting. Sketches can usually be made during cutting periods.

k. Machine work -- Shaper. The setting of the piece, and the grinding and setting of the tool are highly important in this work. A fine finish can be obtained as described under Engine Lathe Work.

l. Machine work -- Slotter. Some work on the slotter is very similar to shaper work and should be treated accordingly. Keyseating as a rule, however, requires different treatment owing to the spring in the tool.

m. Millwright work. Practically all of this work is done out in the plant so that a knowledge of the various departments and the location of the mechanical equipment is of particular value. Often two or more men work together and the timing becomes complicated, especially if all do not work on the same details. Let the watch run on until all are on one detail when it may be snapped back. To be of value for comparative work the study must be detailed; hence do not run details together except when unavoidable.

6. General Instructions for Writing-up Time Studies.

Considerable care should be exercised in making a neat, accurate, and intelligent record of what was observed. If the study is short, list detail operations on the summary sheet (see exhibit #12, page 71). If space does not permit of this, the "second sheet" (see exhibit #13, page 72) should be employed, reserving the summary sheet for other purposes. In the description of details make it plain what was done and arrange the work so that complete operations stand out clearly. In making allowance for the standard against the actual time good judgment and consistency are required. Standards will be established eventually for many elemental details which will aid in making uniform allowances. If necessary regular details were performed to the satisfaction of the observer, then usually the actual time should be allowed toward the standard. Necessary irregular details are not allowed toward the standard directly but are taken care of in the "delay factor". Unnecessary details are of course not allowed and show up in the summary along with the necessary irregular items as "time not allowed". The usual delay factor is ten percent of the allowed time, but this may be changed to meet unusual circumstances. The delay factor takes care of necessary interruptions in the work such as irregular operations, rest, et cetera.

The summary sheet was designed for a definite purpose, namely, to record and present the outstanding facts of the study without referring to the "second" or detail sheets. Fill in all the data called for and add such other as may be of value. If detail observations do not appear on the summary sheet, the major divisions of the job -- operations complete in themselves -- should be tabu-

lated thereon with "allowed time" therefor shown in the proper column. Below these entries should be recorded such details with their allowances as will be of particular value for comparison -- as the foundation for elemental detail standards. A sketch or sketches on much of the work is essential; on nearly all the work, helpful. These may be made in pencil; all other work should be in ink. The recommendation for standard time should be placed on the study only after closely examining the detailed time and carefully weighing the factors entering into the determination of the standard.

7. Specific Instructions for Writing-Up Time Studies.

a. Machine work. A systematic arrangement of the write-up is essential. Details should be grouped so that they follow each other in logical sequence and the several observations on the same detail appear side by side. Average the observed time for a detail before making an allowance for the standard. In this average do not include the observation on the first piece finished by the operator. Study the observed time and compare it with the average. A good rule to follow is to allow toward the standard the next to the lowest observed time or the lowest if it occurs more than once, provided it is not too far below a fair average.

8. General Instructions for Establishing the Proposed Time as a Standard.

Submit the study in person to the Head of the Department for checking and approval. After it has been signed and given an index number and a time study number, it is presented to the

foreman for his approval. The Master Mechanic's signature is next secured, but as there is likely to be a delay in this step, it is permissible to announce the standard after securing the foreman's approval. In giving out the standard, considerable tact is occasionally required. (In some cases it is advisable for the foreman to give out the standard). If a workman objects and is sincere in his objection, it is well to explain, without going too much into detail, where and why certain items were cut out or not allowed. There may be a misunderstanding which can be straightened out in this way. Further, many workmen do not always realize that as their familiarity with certain work grows, their efficiency on the same increases rapidly; hence the Company does not expect the standard to be equalled by the average workman the first time he tries it. Emphasize the fact that down to a certain limit, bonus is paid for efficiencies under 100 percent. After the time study man has used such points as he sees fit in discussing the matter and the workman is still unwilling to accept the time, he should consult the Head of the Department, Rarely will it be advisable to re-time the job, but if re-timed the work must be carried out as outlined in the time study, and then if it is plainly seen that the standard is impossible, it may be changed to conform with results obtained in the re-timing.

9. Work other than Time Study.

It is often impracticable to provide standards for certain classes of work by means of the actual time study. The "Figured Time Study", resulting in the "Figured Standard", takes care of a large number of such jobs which otherwise would be neg-

lected, and time study men when sufficiently prepared will be called upon to do this work.

An occasional intensive investigation for a week or so into every job performed is of real value to the Department in determining where and just how, effort is best expended. Work is classified and divided as follows:

1. Jobs permitting of immediate and accurate time setting
   a. On standard time at time of investigation.
   b. Not on standard time at time of investigation.
2. Jobs not permitting of immediate and accurate time setting
   a. Possible and feasible to put on time eventually.
   b. Impossible, or not feasible to put on time eventually.

The time study men prepare detail information sheets for each workman and, in conference with the Head of the Department, discuss and classify each job. Percentages and other data of great value are thus obtained.

The revision or compilation of machine schedules, handbooks, et cetera, will from time to time be necessary and will serve as "fill-in" work.

Co-operation to secure maximum results in the maintenance departments and this Department in particular is expected.

IV. Instructions to Time Clerks.

1. General

Time clerks record the progress of work in their respective operating departments. If correctly made out, the work cards will give to the Department office, Shop Timekeeper, and Shop

Accountant the information required without trouble or delay; but if a mistake in a vital item creeps in there is bound to be trouble and confusion. However hurriedly written, pains must be taken to get the essential items attended to, and the cards should never be turned over to the office until it is certain they are correct in every detail.

Personally check up the changes made from one job to another (as far as possible) and see that these changes are reported at the proper time. When a time study man begins a study, the workman should change his ticket, making report of progress up to the change.

Take an active interest in getting work covered by standard time. Become familiar with the standard time handbook so that information in it may be secured quickly and accurately. In case there is no standard for a job which you believe it worth while to time, notify the Department office.

One essential should be borne in mind: keep no one waiting at the ticket window any longer than is necessary.

2. Specific

Time is recorded decimally (see exhibit # 7, page 63), i.e., 3 to 9 minutes after 7 A.M. is entered as 0.1; 39 to 45 minutes after 3 P.M. as 7.7; 5:57 to 6:03 as 10.0.

It will pay to be neat and careful in making out the cards. See that the carbons are out to the corners, for if they are not, a date, check or order number may be missing on one or more of the copies.

Do not erase unless all copies are erased. It will usually be easier to draw a line through the item to be changed and write the correction elsewhere.

The following list and explanatory paragraphs show what is required on the work card and why this information must be correct (see exhibit #5, page 62)

1 - Date
2 - Name of employee
3 - Check number of employee
4 - Hours brought forward, if any
5 - Machine number
6 - Department number
7 - Account number
8 - Shop order number
9 - Indications as to starting, continuing, and finishing job
10 - Delay, if any, with cause
11 - Rate, in code form
12 - Adequate and reliable description of job
13 - Standard time
14 - Authority for standard time
15 - Time started
16 - Time finished
17 - Time elapsed
18 - Wages

(1) Date. This must necessarily be correct for reference and filing.

(2) The name of employee. The same check number might be given to different men in the course of a year or two. Hence both the check number and name of the workman are necessary to identify him.

(3) The check number of employee. The original copies are filed two ways: first as to check number, second as to date. Thus any individual's cards for any particular period can be produced immediately from the file.

(4) Hours brought forward, if any. Workmen often wish to know their standing in hours worked on a job. If the total hours to

date are kept forwarded from card to card as the job is continued, this information can readily be furnished.

The total hours as brought forward on the finished card serve to check the bonus clerk's figures. Care should be exercised in adding if this item is to be of value.

(5) Machine number. If work is done on the lathe, milling machine, planer, et cetera, the number of the machine should be recorded. Somewhere in the description the class of machine should appear. Thus the exact machine is defined, the speed and feed of which may be different from others of the same class.

Plats showing machine location are furnished as an aid in this connection.

If bench work is being done, a capital "B" should be written in the space marked "Machine No. ".

(6) Department number. The space marked "Dept. No." is for the number of the department to which the workman belongs, and for that number only. As the cards are filed according to departments, these numbers must necessarily be correct.

(7) Account number. This is very vital since the labor distribution depends upon this item. Be sure that the account number on the card is the same as that on the order; do not change it even if incorrect -- the shop accountant will do that.

(8) Shop order number. The work card is the basis of the cost system for work done by the maintenance departments. The second copy of the card is filed by shop order number, and the labor done in

connection with any particular order is thus easily obtained no matter how many workmen or how many operations, perhaps complete in themselves, are involved.

The apparently small matter of using the correct order number is in reality a very vital and important one. The following are some of the more common mistakes which should be avoided:

a. Incorrect copying of number from order to work card,
b. Putting more than one order number on a single card,
c. Getting number mixed with other order numbers on continued cards,
d. Resurrecting and using the number of an order previously sent to the shop accountant as completed.

(9) Indications by check marks as to starting, continuing, and finishing job. This is especially important to the bonus clerk in making out his bonus records, and to one hunting information in the files. As some jobs run intermittently through several weeks, these check marks become of great value to the work. Each card must have two check marks.

(10) Delay, if any, with cause. Delays should be kept off of work cards just as much as possible. Ordinarily the repairing of a belt or waiting for stock should not be allowed. It is well, however, to state what delays occur and the time involved, as a matter of record.

(11) Rate, in code form. The employee's rate in code form should appear in the proper space. This is done primarily for future reference. It also helps the bonus clerk in checking over the wage extensions.

(12) Adequate and reliable description of job. This item without a

doubt is the most important of all. Use judgment in wording the description of a job. Make it a point to see -- at any rate to understand -- what the workman is doing.

Different operations of any consequence, each complete and separable, must not be run together on one card, especially when all operations are not covered by standard time. Never should operations on more than one order number be placed on one ticket.

The following generalizations are of practically no value:

"Repairing machine",
"Making steel bushings",
"Planing castings",
"Drilling holes"

Valueless information should be caught the next day by the time study man who checks the cards, and those which are incomplete should then be returned immediately to the time clerk who will obtain definite and reliable information while it is still fresh in the mind of the men whose work is recorded. Delay will most likely cause the records to be useless and so should not be tolerated at any time.

For machine operators a description of the work performed should include:

a. The operation; such as, plane, shape, mill, et cetera,
b. Number of pieces to be made on job and number of pieces finished each day,
c. Name of article and part number if any,
d. For what machine or job,
e. Rough and finished sizes of stock,
f. Sketch or drawing number if any -- otherwise a sketch with dimensions,
g. Kind of material.

For millwrights or machine repair men, the name, number, and location of the machine upon which the work is done and the itemized repairs made, should appear on the work card. It is not necessary on a continued job of long duration to write all this information on each card. If possible get it on the first ticket so that a standard may be set. By all means get it on the last or "finished" card. If the workman has one or more helpers, their check numbers should appear at the bottom of the card. The helper's card should also show the check number of the man he helped.

(13) Standard time. Standard time should be placed on the card when the job is started, or very soon thereafter. The workman must be informed what the standard is.

(14) Authority for standard time. When the standard is obtained from the handbook, the index and sheet number from which it is taken must be placed on the card. If the job is being timed, the words "Time study by Blank" should be written on the card and the standard obtained from the time study man. The standards figured from schedules or set by comparison must have the initials of the computer written at the bottom of the card. Times given as standards by the employees should be followed by a question mark and should be investigated immediately.

(15) Time started. This should be the same as the time finished on preceding ticket unless starting the first thing in the morning. This is important, as a man's "card" hours must total his full working hours as shown on the clock slip.

(16) Time finished. Synonymous with preceding article.

(17) Time elapsed. This is the time between starting and finishing or from one change to another. Accuracy is required in subtracting, as all cost data is derived from the extension of this time into wages.

(18) Wages. Obtained by multiplying elapsed time by rate. Use tables provided for purpose.

V. Instructions to Bonus Clerk.

1. General

The clerical and stenographic work of the Department office is done by the bonus clerk. It is essential that all office files and records be up-to-date and correct, for when information is wanted, it is wanted without delay and must be reliable. It is obvious that bonus earnings must be accurately figured. The intelligent use of the ordinary slide rule and the Comptometer is very helpful in much of the computing. An intimate knowledge of the office end of the bonus system, familiarity with shop terms and the more common standard times, and co-operation with the rest of the Department are appreciated in the bonus clerk.

2. Specific

Routine duties are as follows:

Daily:

a. Check work cards for correct date, rate, time and wage extensions, and missing items, if any.

b. Total the hours on continued jobs turned in as completed and figure bonus on same.

c. Post number of time studies and figured or temporary times, with hours covered.

d. Post time record for total actual hours and total actual hours on bonus, per man.

e. Check total hours on cards against clock slips.

f. Remove carbons from work cards; separate, and divide originals into

(1) finished standard
(2) finished no standard
(3) continued;

put continued tickets in continued file; send first carbon copy to Timekeeper, second copy to Shop Accountant, and third copy to time clerks.

g. Post completed bonus jobs on individual effort record cards and follow-up record cards.

Weekly: a. Prepare bonus report from individual effort cards and send to Timekeeper in time to make out payroll.

b. Prepare individual effort checks and deliver for distribution to workmen through foremen on the day preceding payday.

c. Prepare weekly summary as follows:

(1) Figure percentage of time covered from daily time record.
(2) Get average number of men, and men on bonus from daily time record.
(3) Total the number of studies, et cetera, with hours covered.
(4) Figure average percentage of efficiency by departments.
(5) Enter bonus earned from bonus report.
(6) Compute savings by departments according to the following formula:

$$(1.5\ S + .60\ (1.5S)) - (A + .60\ A + B) = \text{Savings}$$

or expressed more simply,

$$2.4\ S - (1.6\ A + B) = \text{Savings}$$

where S = Department total of each workman's rate times standard hours on completed bonus jobs

A=Department total of each workman's rate times actual hours on completed bonus jobs

B=Department total of bonus earned.

(7) Enter notations covering exceptions from time covered, et cetera
(8) Bring graph up to date and have blue prints made; send copies of report to Superintendent and Master Mechanic.

d. Post weekly summary data on monthly report forms.

e. File work cards.

Monthly: a. Prepare monthly report as follows:

(1) Make up summary similar to weekly report.
(2) Figure average "wage rate plus bonus" for each workman, by departments, indicating steps and figures used; send copies as of weekly summary.

Semi-annual, and Annual:

a. Prepare report similar to monthly report.

Beside the foregoing routine duties there are the following:

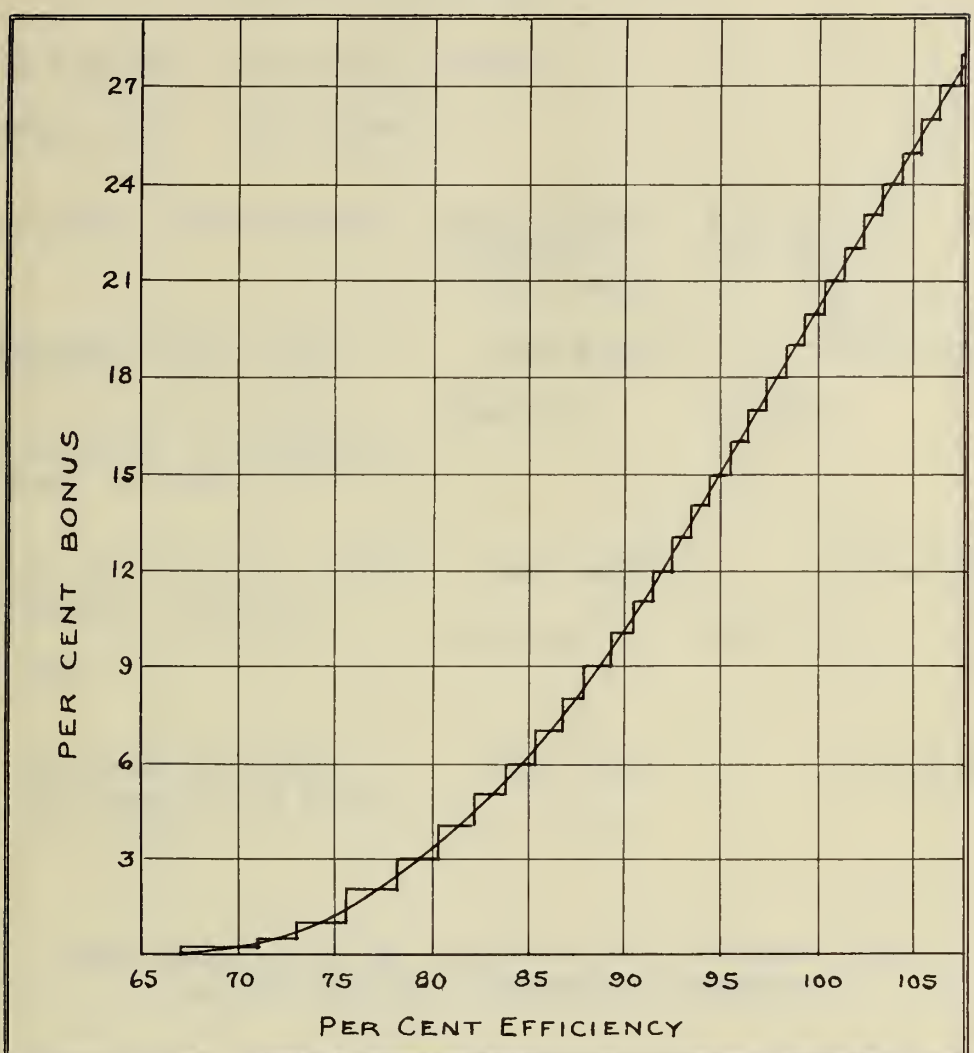
a. Typewriting standard time handbook sheets

b. Preparation of special reports

c. Maintenance of all files.

EXHIBIT No. 1

BONUS CURVE & TABLE



PER CENT EFFICIENCY	PER CENT BONUS	PER CENT EFFICIENCY	PER CENT BONUS
67.00 TO 70.99	¼	90.50 TO 91.49	11
71.00 " 72.99	½	91.50 " 92.49	12
73.00 " 75.59	1	92.50 " 93.49	13
75.60 " 78.19	2	93.50 " 94.49	14
78.20 " 80.29	3	94.50 " 95.49	15
80.30 " 82.19	4	95.50 " 96.49	16
82.20 " 83.79	5	96.50 " 97.49	17
83.80 " 85.29	6	97.50 " 98.49	18
85.30 " 86.69	7	98.50 " 99.49	19
86.70 " 87.99	8	99.50 " 100.49	20
88.00 " 89.29	9	100.50 " 101.49	21
89.30 " 90.49	10	ETC.	

EXHIBIT No. 2 - STANDARD TIME HANDBOOK SHEET

9-13-15 Index No. 162.2

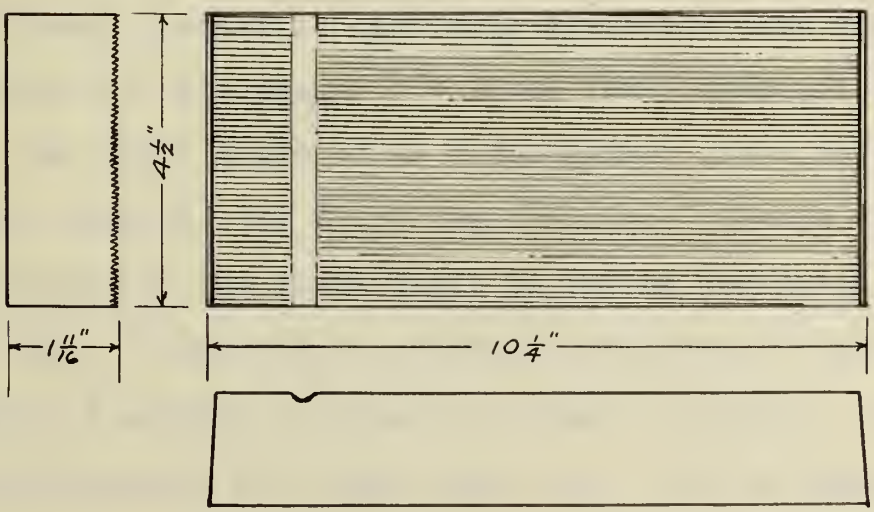
THE A-B-C MFG. CO.

DIES for W-F #40 Roll Threading Machine

S-8125 Sketch 573 C.X. Steel

				T.S.No.
a.	Shape to size from forging	Stationary Traveler Per pair	2.5 hr. 2.0 hr. 4.5 hr.	6577
b-1.	Mill threads (5/16, 3/8, 7/16, or 1/2), and slot (New, or after old threads have been milled off)	Per pair Set-up	3.2 hr. 0.5 hr.	6421
b-2.	Mill off old threads, mill new threads, and slot (Old dies)	Per pair Set-up	4.2 hr. 0.5 hr.	6421
c.	Dress up after milling-round off threads at ends, sides, and slot	Per pair	1.5 hr.	6422

NOTE- R.p.m. of 20 and feed of 0.5" must not be exceeded on account of cutters.



Sheet No. 614

(SOMEWHAT COMPRESSED - ACTUAL SIZE: 8½"×11")

EXHIBIT No. 3 DECIMAL INDEX

EXPLANATION OF THE DECIMAL SYSTEM

The fundamental characteristic of this system is the method of division and subdivision employed. Everything upon which work is performed by the maintenance departments is divided into six specific classes and one of a general nature, leaving three digits for other classes which can be added should it become necessary.

0 General
1 Dies
2 Jigs, Fixtures, and Gauges
3 Tools
4 Machines
5 Conveyors
6 Dust Collection System
7
8
9

Each of these classes is similarly divisible into ten sections, sections into divisions, divisions into subdivisions, and so on. The first digit of an index number gives the class, the second the section, the third the division; then a decimal point is inserted and the first digit to follow indicates the subdivision, etc. Thus 121.1 indicates subdivision 1 of division 1 (punch) of section 1 (press) of class 1 (dies). 121.11 indicates round punches for punch press dies, 121.12 square punches.

DECIMAL INDEX

0 - GENERAL

000. Miscellaneous

010. Factory product parts (requiring special work not possible in regular manufacturing depts)

020. Steel stamps and stencils

030. Parts for physical or chemical analysis

040. Minor foundry equipment such as chills, metal jackets, etc.

1 - DIES

100. General

101. Hand forms

102. Wire Dies

110. Drop hammer dies - general

111. Welding

112. Bending

113. Setting

120.

EXHIBIT No. 3 (CONT'D)

120.	Press dies - general	
121.	Punching	
121.1		Punches
.11		Round
.12		Square
.13		Slot (oval)
.14		Rectangular
.15		Keyslot
.16		Countersunk
121.2		Die bushings
.21		Round
.22		Square
.23		Slot (oval)
.24		Rectangular
.25		Keyslot
.26		Countersunk
121.3		Chucks
.4		Blocks - top and bottom
.5		Gauges
.6		Strippers
122.	Bending	
122.1		Top and bottom dies or die plates
.2		Blocks- top and bottom
.3		Gauges
123.	Blanking	
123.1		Punches
.2		Blades or plates (includes backing plates)
.3		Blocks - top and bottom
.4		Gauges
.5		Strippers

124.	Trimming or shearing
124.1	Trimmers
.11	Single radius
.12	Double radius
124.2	Trimmer Blades (also backing plates)
.3	Shear Blades
.4	Chucks
.5	Blocks
.51	Die
.52	Shear
124.6	Gauges
.7	Strippers
130.	Hammer dies (spring, Bradley, steam)-general
131.	Welding
132.	Plating
133.	Pointing
134.	Forging
140.	Forging machine dies - general
141.	Upsetting
142.	Bending
150.	Bulldozer dies - general
151.	Bending
151.1	Blocks or forms
.2	Clamps
.3	Gauges
152.	Drifting

EXHIBIT No. 3 (CONT'D)

160. Bolt dies - general

161. Header and trimmer dies

162. Threading dies

162.1 Machine (Landis, etc.)

.2 Roll

163. Eyebolt dies

170. Special roll dies

180. Special tempering press dies

2 - JIGS

200. General

210. Bench jigs

211. Erecting or assembling

212. Testing or checking

220. Machine jigs

221. Drilling (includes drill bushings)

222. Milling

223. Grinding

224. Shaping

225. Riveting

230. Inspectors' jigs, blocks, and gauges

240. Gauges (plug, ring, etc.)

3 - TOOLS & ACCESSORIES

300. General

310. Cutters

311. Milling

312. Hollow mills

320. Drifts

321. Hand

322. Machine

323. Dies

324. Chucks

330. Drill press tools

331. Drills

331.1 Flat

.2 Twist

332. Taps

332.1 Ordinary

.2 Collapsible

333. Countersinks

334. Counterbores

335. Reamers

336. Chucks, sockets, and sleeves

340. Hammer heads

350. Wrenches

360. Air tools

4 - MACHINES

400. General

401. Maintenance dept., boiler and engine rooms, and laboratory machines
402. Standard product working machines (not under other headings)
403. Shafting, hangers, and pulleys not included with machines
404. Safety devices - for all machines

410. Wood working machines - general

411. Saws and appliances

412. Boring machines

413. Surfacers and trimmers

414. Lathes

415. Sanders

416. Bending machines

420. Grinders and polishers - general

421. Motor grinders

421.1 Base and accessories

.11 Base
.12 Doors, knob, etc.
.13 Starting lever, etc.

EXHIBIT No. 3 (CONT'D)

421.2	Housings, etc.
.21	Housings for B. and R.B. grinders
.22	Inner and outer bearing cup adj.nuts
.23	Bearing caps, etc.
.24	Tool box, etc.
421.3	Shaft and accessories
.31	Shaft for B. and R.B. grinders
.32	Inside and outside washers for shaft
421.4	Hood and wheel guard, etc.
422.	Belt grinders
422.1	Small (14" or under)
.2	Large (over 14")
423.	Polishing wheels and parts
424.	Grinder or polisher cradles
430.	Presses - general
431.	Drilling
432.	Punching or shearing
433.	Setting
434.	Stamping
435.	Tempering
436.	Air presses for riveting
440.	Hammers - general
441.	Drop (rope and board)
442.	Spring
443.	Bradley cushion
444.	Steam
450.	Bulldozers - general

460. Forging machines - general

470. Bolt and nut machines

471. Threading machines

471.1 Landis, etc.

.2 Roll

472. Gang nut tappers

473. Eye benders

474. Bolt headers

5 - CONVEYORS

500. General

510. Special - general

511. Warehouse, cut

512. Warehouse, in

520. Elevators - general

530. Lifts and hoists - general

531. Electric

532. Air

533. Rope

540. Carriers (overhead trolley) - general

541. Track

542. Hangers, etc.

EXHIBIT No. 3 (CONCLUDED)

550. Trucks - general

551. Standard hand,- for steel parts

552. Electric tractors

6 - DUST COLLECTION SYSTEM

600. General

610. Emery collector boxes and piping

620. Separators (dust boxes) and piping

630. Emery reclamation equipment

EXHIBIT No. 4

FOLLOW-UP RECORD

ARTICLE_____ INDEX No._____

HAND BK. SHT. No._____

DATE	CHECK No.	No. PCS.	OPERATION	TIME		EFFIC.	REMARKS
				ACT.	STD.		

(FULL SIZE)

EXHIBIT No. 5

WORK CARD

DATE EMPLOYEE CK. No.

FORWARD	MACH. No.	DEPT. No.	STD. ACCT.	S.O. No.

START	CONT'D	FINISHED	DELAY	RATE

	STANDARD TIME	
	TIME FINISHED	
	TIME STARTED	
	ELAPSED TIME	
	WAGES	
	BONUS	
	TOTAL	
AUTHORITY FOR STD. TIME-	PER CENT EFFIC.	

(FULL SIZE)

EXHIBIT No. 6

DATE _____ No. _____

THE A-B-C MFG. CO.

INDIVIDUAL EFFORT CHECK

NAME _____ CHECK No. _____

STANDARD TIME _____ HRS. EFFIC. % _____

ACTUAL TIME _____ HRS BONUS $ _____

WEEK ENDING _____

CHECKED BY _____

(FULL SIZE)

EXHIBIT No. 7

DECIMAL CLOCK FACE

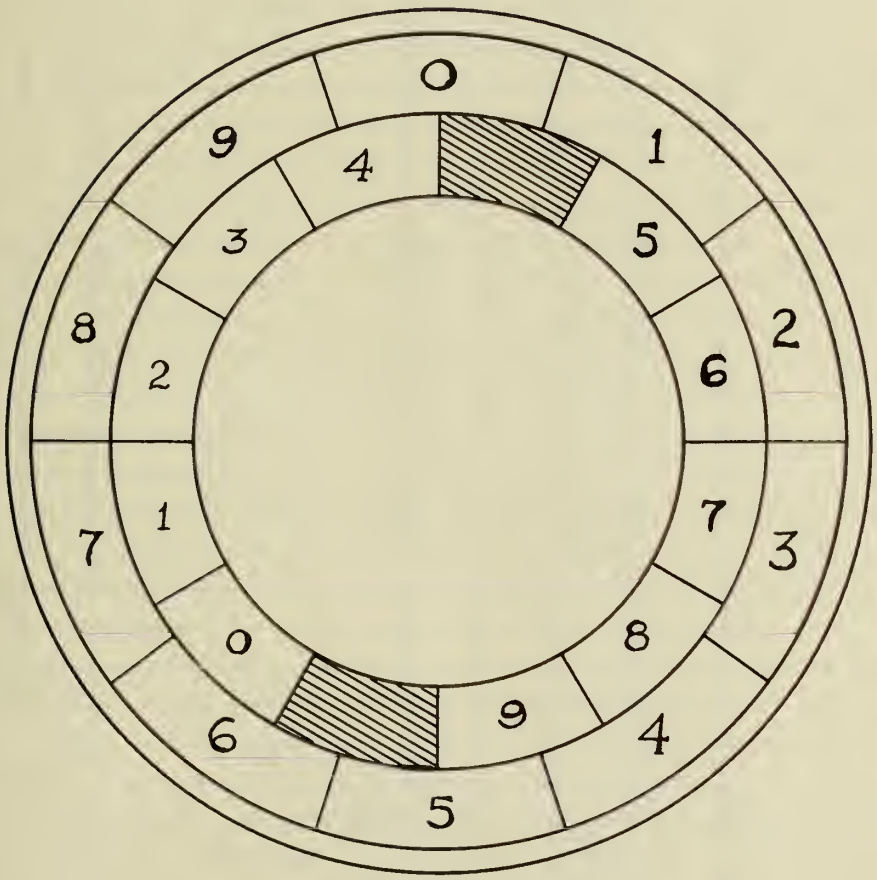


EXHIBIT No. 8

INDIVIDUAL EFFORT RECORD

NAME_____ RATE_____ CK.NO._____

DATE	No. Pcs.	OPERATION	TIME		EFFIC.	BONUS	REMARKS
			ACT.	STD.			

(FULL SIZE)

EXHIBIT No. 9

April 3, 1916

Shop Timekeeper:

Herewith list of bonus earnings of workmen in maintenance departments for week ending April 1.

3905	(Name)	1.38	
3909	"	4.06	
3911	"	2.79	
3917	"	.63	
3919	"	.26	
3920	"	6.37	
3923	"	6.84	
3928	"	.11	
3929	"	.20	
3941	"	.01	22.65
4003	"	5.40	
4004	"	1.98	
4032	"	.28	
4037	"	3.65	
4038	"	1.31	
4048	"	1.02	13.64
4303	"	8.12	
4308	"	2.01	
4309	"	.82	
4314	"	8.47	
4316	"	9.21	
4320	"	9.10	
4321	"	3.49	
4322	"	10.65	
4323	"	.11	
4324	"	5.59	
4327	"	6.83	
4329	"	.97	
4334	"	2.17	
4335	"	11.12	
4336	"	2.61	
4337	"	7.76	
4338	"	.38	89.41

Total for 3 departments - - - - - - - 125.70

Yours truly,

_____

EXHIBIT No. 10

April 3, 1916

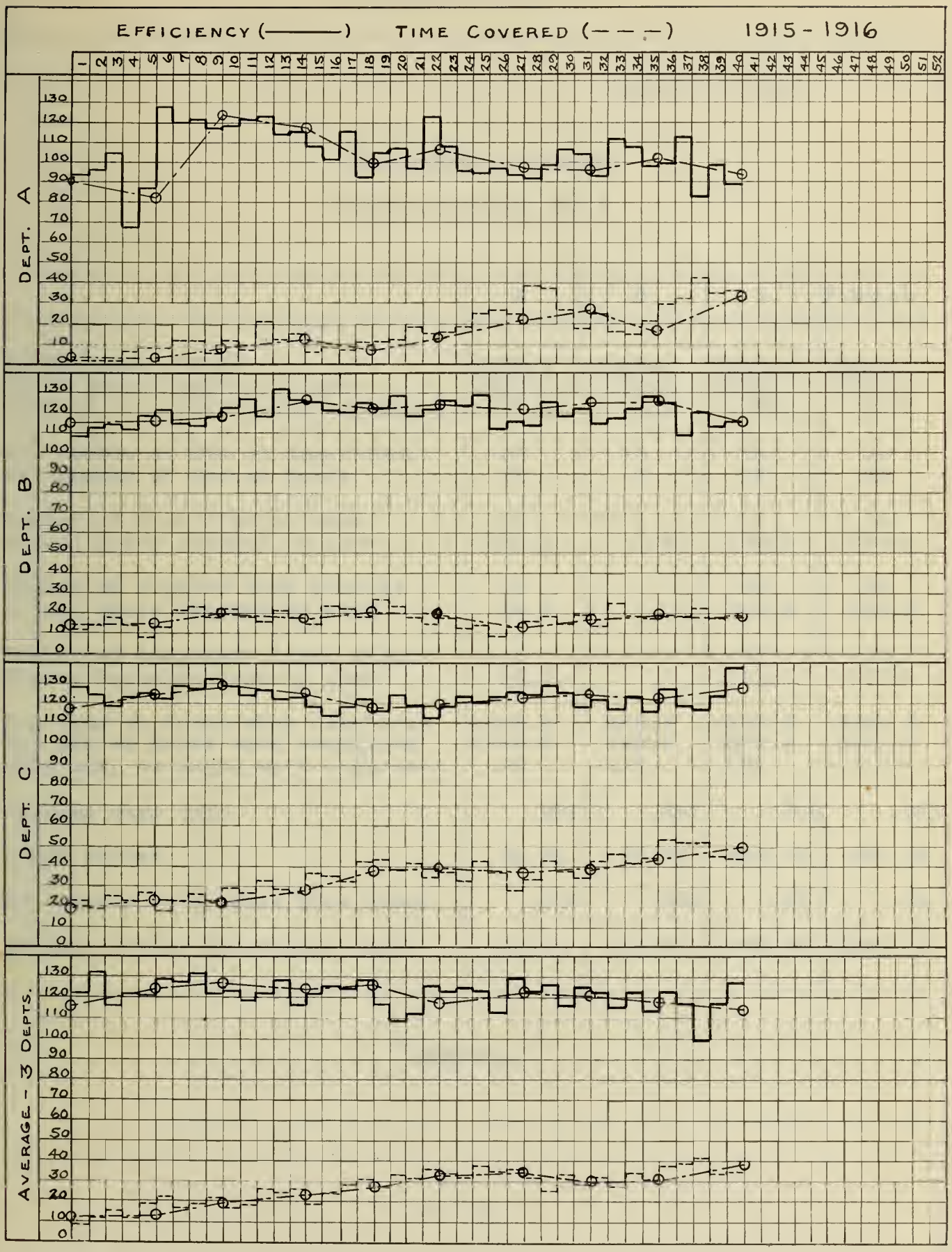
DEPARTMENT SUMMARY

Week ending - 4/1- 1916.

	A	B	C	3 Depts.
Total actual hours	729.1	792.8	1160.2	2682.1
Total actual hours on bonus	269.8	152.1	490.7	912.6
Percent of actual hours covered	37.0	19.2	42.3	34.0
Number of men in department	13	13	21	47
Number of men on bonus,	10	6	17	33
Number of time studies made	3	1	3	7
Actual hours covered by same	41.3	2.0	12.0	55.3
Number of figured time studies	4		17	21
Actual hours covered by same	22.0		107.3	129.3
Number of temporary times given			1	1
Actual hours covered by same			11.9	11.9
Std. time on bonus work completed	303.6	178.5	687.5	1169.6
Act. hrs. on bonus work completed	269.3	153.8	495.8	918.9
Av.% eff. on bonus work completed	113	116	139	127
Bonus earned	22.65	13.64	89.41	125.70
Savings (after deducting bonus)	52.69	31.56	172.32	256.57

(REMARKS)

EXHIBIT No. 10 (CONT'D)



(TRACING — BROUGHT UP TO DATE WEEKLY)

EXHIBIT No. 11

April 3, 1916

DEPA RTMENT SUMMARY

Month of March, 1916

	A	B	C	3 Depts.
Total actual hours	3538.3	4022.2	6899.4	14459.9
Total actual hours on bonus	1251.6	733.6	3318.1	5303.3
Percent of actual hours covered	35.4	18.2	48.1	36.7
Av. number of men in department	13	13	24	50
Av. number of men on bonus	10	6	19	35
Number of time studies made	18	1	15	34
Actual hours covered by same	181.6	2.0	105.2	288.8
Number of figured time studies	15		75	90
Actual hours covered by same	89.0		503.8	592.8
Number of temporary times given	1		17	18
Actual hours covered by same	36.3		151.1	187.4
Std time on bonus work completed	1638.3	865.6	4163.3	6667.2
Act hrs on bonus work completed	1786.5	741.0	3370.4	5897.9
Av.% eff. on bonus work completed	92	117	124	113
Average wage rate	.299	.287	.305	.298
Bonus earned	88.59	67.88	450.71	607.18
Av. hourly rate, wage plus bonus	.324	.303	.37	.34
Savings (after deducting bonus)	189.91	154.02	950.20	1294.13

(REMARKS)

EXHIBIT No. 11 (CONT'D)

INDIVIDUAL EFFORT REPORT

For Month of March, 1916

(1)

Check No.	Name	Wages			Bonus				E+I Total Wages	J÷C Av. Rate
		Act. Hrs.	Rate	Amount	Act. Hrs.	Std. Time	Eff	Am't		
A	B	C	D	E	F	G	H	I	J	K
3905		210.0	.125	26.25	152.2	139.1	92	3.27	29.52	.140
3909		285.0	.350	99.75	157.8	169.5	107	15.14	114.89	.403
3910		278.1	.325	90.38	9.2	6.8	74	.11	90.49	.325
3911		260.0	.275	71.50	152.8	162.8	107	11.60	83.10	.320
3916		288.1	.350	100.84	1.2	1.2	100	.08	100.92	.350
3917		231.5	.325	75.24	98.8	95.3	96	6.13	81.37	.348
3919		297.9	.325	96.82	60.3	48.0	80	.86	97.68	.328
3920		272.0	.200	54.40	259.6	347.4	134	27.63	82.03	.302
3923		298.9	.325	97.14	52.0	68.7	132	8.79	105.93	.354
3928		278.8	.350	97.58	89.0	89.0	100	6.23	103.81	.373
3929		290.0	.325	94.25	69.3	81.8	118	8.73	102.98	.355
3940		294.0	.300	88.20	83.5	27.7	33	.00	88.20	.300
3941		254.0	.258	65.33	600.8	401.0	67	.02	65.35	.258
		3538.3	.299	1057.68	1786.5	1638.3	92	88.59	1146.27	.324
4003		361.3	.250	90.33	177.1	232.8	132	22.75	113.08	.314
4004		303.2	.225	68.22	56.9	80.3	141	7.79	76.01	.251
4010		311.7	.300	93.51	1.2	1.2	100	.07	93.58	.300
4014		299.6	.300	89.88	12.5	8.1	65	.00	89.88	.300
4024		345.5	.325	112.29	1.2	1.2	100	.08	112.37	.325
4032		298.0	.275	81.95	17.5	31.0	177	4.68	86.63	.291
4036		276.5	.275	76.04					76.04	.275
4037		312.4	.225	70.29	263.8	305.2	116	21.20	91.49	.293
4038		332.1	.300	99.63	198.5	183.5	93	7.52	107.15	.323
4039		318.2	.300	95.46					95.46	.300
4040		275.9	.325	89.67	1.8	2.9	161	.48	90.15	.327
4048		282.6	.300	84.78	9.3	18.2	196	3.23	88.01	.311
4049		305.2	.325	99.19	1.2	1.2	100	.08	99.27	.325
		4022.2	.287	1151.24	741.0	865.6	117	67.88	1219.12	.303

(REMARKS)

EXHIBIT No. 11 (CONCLUDED)

(2)

Check No.	Name	Wages			Bonus				E + I Total Wages	J ÷ C Av. Rate
		Act. Hrs.	Rate	Amount	Act. Hrs.	Std. Time	Eff	Am't		
A	B	C	D	E	F	G	H	I	J	K
4303		277.0	.325	90.03	68.2	111.2	163	18.34	108.37	.392
4306		198.8	.250	49.70	88.9	127.2	143	14.03	63.73	.321
4307		275.0	.200	55.00	3.6	3.6	100	.14	55.14	.201
4308		294.0	.350	102.90	211.8	223.8	106	19.22	122.12	.416
4309		264.0	.225	59.40	174.5	206.3	118	15.36	74.76	.283
4310		102.5	.350	35.88	62.1	90.8	146	14.33	50.21	.490
4314		294.0	.350	102.90	270.5	360.3	133	50.44	153.34	.522
4315		107.6	.325	34.97	37.3	60.8	163	10.09	45.06	.419
4316		284.4	.350	99.54	208.3	218.2	105	18.50	118.04	.415
4318		108.0	.325	35.10	37.8	42.0	111	3.84	38.94	.361
4319		224.9	.350	78.72	71.1	67.0	94	3.65	82.37	.366
4320		273.0	.275	75.08	234.8	314.0	134	34.74	109.82	.403
4321		284.0	.250	71.00	199.1	235.7	118	19.07	90.07	.317
4322		293.8	.325	95.49	197.8	275.0	139	37.88	133.37	.454
4323		253.0	.375	94.88	140.6	171.3	122	22.11	116.99	.463
4324		264.7	.265	70.11	51.3	74.4	145	8.87	78.98	.298
4326		293.7	.350	102.80	99.0	89.4	90	3.79	106.59	.364
4327		294.0	.300	88.20	237.0	294.2	124	31.63	119.83	.408
4328		293.6	.375	110.10					110.10	.375
4329		294.0	.350	102.90	17.4	16.3	94	1.04	103.94	.354
4333		237.0	.350	82.95	1.5	1.5	100	.10	83.05	.350
4334		275.8	.200	55.16	275.8	275.8	100	11.03	66.19	.240
4335		293.0	.340	99.62	279.8	377.9	135	52.43	152.05	.520
4336		269.0	.270	72.63	152.2	165.7	109	12.10	84.73	.315
4337		294.9	.300	88.47	204.1	313.9	154	45.29	133.76	.454
4338		292.7	.275	80.49	24.2	24.5	101	1.40	82.89	.280
4340		263.0	.262	68.90	21.7	22.5	104	1.29	70.19	.267
		6899.4	.305	2102.92	3370.4	4163.3	124	450.71	2553.63	.370

(REMARKS)

EXHIBIT No. 12

DATE _____ TIME STUDY INDEX No. _____ SHEET No. 1

ARTICLE _____ TIME STUDY No.

FOR

PART No. NUMBER MADE PER YEAR | SPEEDS, FEEDS, ETC.

DWG No. MAT'L – FORG'G STK DEPARTMENT

ORDER No. C'STG REW'KD OPERATOR No. NAME RATE

KIND – MACHINE No. KIND

OPERATION:

REMARKS:

SKETCH
(ROUGH & FINISHED SIZES)

DESCRIPTION OF OPERATIONS	OBSERVED TIME (DECIMAL)						ALLOWED	
	FIRST	SECOND	THIRD	FOURTH	FIFTH	AVERAGE	FIRST	EA. ADD.
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
6								
13								
14								
15								
16								
17								
18								
19								
20								
TOTAL								

TOTAL ACTUAL TIME

LESS TIME NOT ALLOWED _____

TIME ALLOWED STANDARD TIME

PLUS % DELAY FACTOR _____

COMPLETE TIME

DATE OF H.O. SHEET

CHECKED AND APPROVED BY DATE POSTED IN SHOP

APPROVED BY FOREMAN APPROVED BY MASTER MECHANIC

OBSERVER

(SOMEWHAT COMPRESSED – ACTUAL SIZE: 8½" × 11")

EXHIBIT No. 13

TIME STUDY

INDEX No. _____ SHEET No. ___

TIME STUDY No.

DESCRIPTION OF DETAILED OPERATIONS	OBSERVED TIME (DECIMAL)						ALLOWED	
	FIRST	SECOND	THIRD	FOURTH	FIFTH	AVERAGE	FIRST	EA. ADD
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
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42								
43								
44								
45								
46								
47								
48								
49								
50								
51								
52								
53								
54								
55								
56								
TOTAL								

(SOMEWHAT COMPRESSED - ACTUAL SIZE: 8½" x 11")

UNIVERSITY OF ILLINOIS-URBANA
3 0112 082200087